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Foraminifera from the Jurassic (Callovian - Kimmeridgian) outcrop in Arda Area, Central Jordan

By

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With 2 Figures, 2 Tables and 2 Plates

ABSTRACT

Thirty two foraminiferal species were identified from nineteen samples taken from the uppermost fifty meters of the Jurassic Arda surface section. The microfaunal assemblages suggest a Callovian to Kimmeridgian age for the studied succession.

ZUSAMMENFASSUNG

Aus den obersten 50 Metern der Jura-Schichten des Arda-Profils (Jordanien) werden 32 Foraminiferenarten vorgestellt. Aufgrund der Mikrofauna ist das Alter mit Callov bis Kimmmeridge anzugeben.

1. INTRODUCTION

In the past the studies on the Jurassic of Jordan were focused mainly on the lithology and to a little extent on the biostratigraphy (Libbey & Hoskins 1905, Cox 1925, Muir-Wood 1925, Blake 1936, Blake & Ionides 1939, Avnimelech 1945, Wetzel & Morton 1959, van den Boom & Lahloub 1962, Bender 1968, Abed 1987 and Amereh 1987). The paleontological aspects were partially treated by Basha (1980: ostracods) and Aqrabawi (1987: macrofauna).

A lot of new data about the Jurassic were yielded during the eighties by oil exploration with many drilling wells in the course of the National Oil Exploration Project, which was initiated by the Natural Resources Authority of Jordan (NRA). These exploration data are an important contribution to the geology of Jordan, especially to the knowledge of the Jurassic system, the surface outcrops of which are restricted to limited areas in Central Jordan. The results show an increase in thickness of the Jurassic sediments from Central Jordan to the North and West and a dominance of sandy facies in the eastern and partially in the southern areas, while calcareous facies predominantly occur in the paleogeographically deeper areas in northern and western parts of Jordan.

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2. THE ARDA SURFACE SECTION

The Arda area is situated about 35 kms WWN of Amman (Fig. 1). Due to the severe tectonic movements in the course of the development of the Jordan Graben which were accompanied by faults and an extreme folding of rock units, only the uppermost 50 meters of the outcrop section could be studied in detail in the area of study.

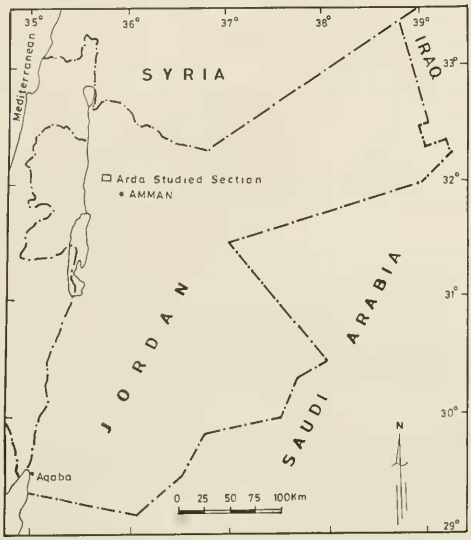


Fig. 1: Location of the Arda Area.

This Jurassic succession is characterized lithologically by being mainly calcareous (Fig. 2). At the base it starts with some marly sandy clays, which are followed upwards by thick sequences (ca. 20 m) of clayey marls with secondary gypsum fissures. Above these marls a thick sequence of generally thin, more rarely thick bedded dolomites and limestones follows, which alternate with thin to medium thick marl beds rich in macrofossils (mainly brachiopodes; terebratulids and rhynchonellids). The uppermost part of the section, 6 meter thick, consists of dense compact dolomite beds. The Jurassic series underlie a thick sandstone sequence of Lower Cretaceous age.

19 soft samples (AR Samples), mainly marls to clayey marls in composition, were taken from the uppermost 50 meters of the Jurassic, prepared and analysed with respect to their faunal content. Table 1 gives an overview of the faunal content of the AR samples.

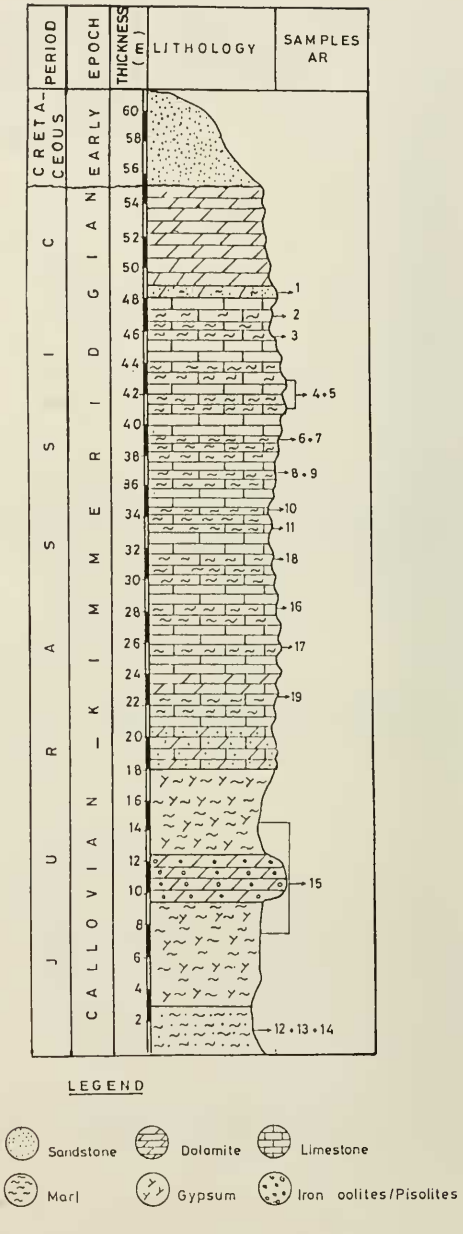


Fig. 2: The Jurassic Arda surface section.

SAMPLE NR.	FAUNAL CONTENT
AR-1	brachiopodes and rare crinoid plates
AR-2	no fauna
AR-3	no fauna
AR-4 + AR-5	highly fossiliferous: echinoid spines, holothurians, brachiopods, ostracodes and foraminifera
AR-6	echinoid spines, bryozoans, ostracodes and foraminifera
AR-7	highly fossiliferous: brachiopods, echinoid spines, gastropods (moulds), crinoid elements, bivalves, fish teeth and foraminifera
AR-8	no fauna
AR-9 + AR-10	crinoid plates, echinoid spines
AR-11	no fauna
AR-12 - AR-14	no fauna
AR-15	foraminifera
AR-16	bivalvia (internal moulds) and ? fish otolith
AR-17	highly fossiliferous: brachiopods, echinoid spines, crinoid plates, holothurian elements, gastropods, desmons of coralline sponges, ostracodes and foraminifera
AR-18	fossiliferous: echinoid spines, bryozoans, holothurian skeletal elements, desmons of coralline sponges, ostracodes and foraminifera
AR-19	highly fossiliferous: crinoid elements, echinoid spines, bryozoans, bivalves, gastropods, holothurian skeletal elements, ostracodes and foraminifera.

Table 1: Distribution of faunal groups in Arda samples

Excluding those with cf. and up to generic level identified foraminifera taxa, all of the well identified species (except *Ammodiscus zaspelovae*) suggest a Callovian-Kimmeridgian age for the studied section (Table 2). In spite that NAGY et al. (1990) had reported *Ammodiscus zaspelovae* from the Portlandian of Norway, the detailed microscopic examination proved that both the Norwegian and the Jordanian specimens are alike in many aspects (e. g. fine grained to smooth wall, size, coiling). The only explanation, why this species is an index fossil to younger age in Norway is to assume that the ecology in Norway at Callovian-Kimmeridgian times was not suitable for the flourishing of this species.

Foraminifera species	PRE-CALLOVIAN	CALLOVIAN	OXFORDIAN	KIMMERIDGIAN	POST-KIMMERIDGIAN	ARDA SAMPLES
Reophax barnardi				35	Sinai	AR-19
Reophax suevicus			38		Canada	AR-19
Ammobaculites agglutinans			6	6 Fran	Britain ce	AR-19
Ammodiscus zaspelovae					31 Norway	AR-5
Verneuilinoides minuta				35	Sinai	AR-17 and AR 18
Ophthalmidium purtonensis			6	England		AR-17 and AR 18
Paramigros shinnawii	1				Egypt	AR-17 and AR 18
Eoguttulina liassica		6		England		AR-4 and AR-5
Astacolus ectypus		38	Canada			AR-19
Lenticulina magharaensis				35	Sinai	AR-4 and AR-4
Lenticulina quenstedti			35		Sinai	AR-19 and AR-4
			37		England	
Nodosaria metensis			35		Sinai	In most of the samples
Dentalina intorta		26	Germany			AR-5, AR-15, AR-17 and AR-18
Vaginulina "prima"				37	Britain	AR-5

Table 2: The well-identified foraminifera species of the Arda section and their stratigraphic position recorded from occurrences in some other regions (for references see end of the text).

3. SYSTEMATIC DESCRIPTION

For the sake of simplicity, the identified species are listed without mentioning their generic or family classification.

Reophax barnardi SAID & BARAKAT, 1958
Pl. 1, Figs. 3-4

1958 *Reophax barnardi* n. sp. - SAID & BARAKAT: 238, pl. 4, fig. 7.

Remarks: Numerous specimens of this species were extracted from sample AR-19; in all aspects they can be compared with those described from the Kimmeridgian of Sinai by SAID & BARAKAT (1958).

Reophax suevicus FRANKE, 1936
Pl. 1, Figs. 1-2

1976 *Reophax suevicus* FRANKE, 1936. - SOUAYA: 266, pl. 5, fig. 2.

Remarks: This species was reported from Callovian to Tithonian rocks of Canada (SOUAYA 1976). In Arda section tens of specimens could be found in sample AR-19; they are characterized by being coarsely agglutinated, tapering and slightly compressed.

Ammobaculites agglutinans (d'Orbigny, 1846)
Pl. 1, Figs. 5-7

1981 *Ammobaculites agglutinans* (d'Orbigny, 1846). - Barnard et al.: 388, pl. 1, fig. 2.

Remarks: This species is abundant in sample AR-19. It is characterized by having 4 chambers in the planispirally coiled, slightly compressed initial stage which is followed by 2 to 3 uniserial inflated chambers; surface coarsely agglutinated; umbilicus slightly biconcave.

The species is reported from the Middle Jurassic to the Lower Oxfordian of Great Britain (Barnard et al. 1981, Morris & Coleman 1989, Shipp 1989) and the early Kimmeridgian of France (Barnard & Shipp 1981).

Ammodiscus zaspelovae Kosyreva, 1972
Pl. 1, Figs. 8-9

1990 *Ammodiscus zaspelovae* Kosyreva. - Nagy et al.: 989, pl. 1, figs. 4-7.

Remarks: Numerous specimens of this species were present in sample AR-5. The number of whorls around the relatively large proloculus is 6 or more. As outlined by Nagy et al. (1990) this species is known from the Volgian (Portlandian) of Siberia and the Portlandian of Norway.

Haplophragmoides cf. *goodenoughensis* Chamney, 1969
Pl. 1, Fig. 10

cf. 1976 *Haplophragmoides goodenoughensis* Chamney, 1969. - Souaya: 267, pl. 2, fig. 6.

Remarks: Souaya's specimens from Canada are of lowermost Cretaceous age. Nagy et al. (1990) recorded this species from the Portlandian and Lower Cretaceous of Norway. Jordanian specimens extracted from samples AR-4, AR-5 and AR-6 differ from those reported by Souaya in having the umbilical area somewhat inflated rather than deep. Both forms have the same number of chambers (12).

Haplophragmoides cf. *tryssa* Loeblich & Tappan, 1950
Pl. 1, Figs. 11-13

1976 *Haplophragmoides* sp. cf. *H. tryssa* Loeblich & Tappan. - Souaya: 267, pl. 6, fig. 14.

Remarks: The Arda specimens from samples AR-17 and AR-18 resemble in many aspects to those reported and figured by Souaya (1976) from the Oxfordian rocks of Canada but differ in having more and slightly inflated chambers.

Verneuilinoides minuta Said & Barakat, 1958
Pl. 1, Figs. 14-15

1958 *Verneuilinoides minuta* n. sp. - Said & Barakat: 242, pl. 4, figs. 25 a-b.

Remarks: Specimens of this foraminiferal taxon are abundant in AR-18 and AR-17. They show high resemblance with those first identified and described by Said & Barakat (1958) from the Kimmeridgian of Sinai.

Ophthalmidium purtonensis Barnard et al., 1981
Pl. 1, Figs. 16-17

1981 *Ophthalmidium purtonensis* n. sp. - Barnard et al.: 399, pl. 1, figs. 19, 26; text-figs. 9 B, 1-5, 26.

Remarks: This species is common in samples AR-17 and AR-18; Barnard et al. (1981) report it from the Lower Oxfordian of England.

Paramigros shinnawii Abd-Elshafy & Ibrahim, 1990
Pl. 1, Fig. 18

1990 *Paramigros shinnawii* n. sp. - Abd-Elshafy & Ibrahim: 25, pl. 4, figs. 1-2.

Remarks: The specimens of the Arda area correspond well to the description of this species by Abd-Elshafy & Ibrahim, who reported it from Bathonian to Kimmeridgian rocks of Egypt. The species is common in samples AR-17 and AR-18.

Eoguttulina liassica (Strickland, 1846)
Pl. 1, Fig. 19

1981 *Eoguttulina liassica* (Strickland, 1846). - Barnard et al.: 426, pl. 3, fig. 20; text-fig. 29a.

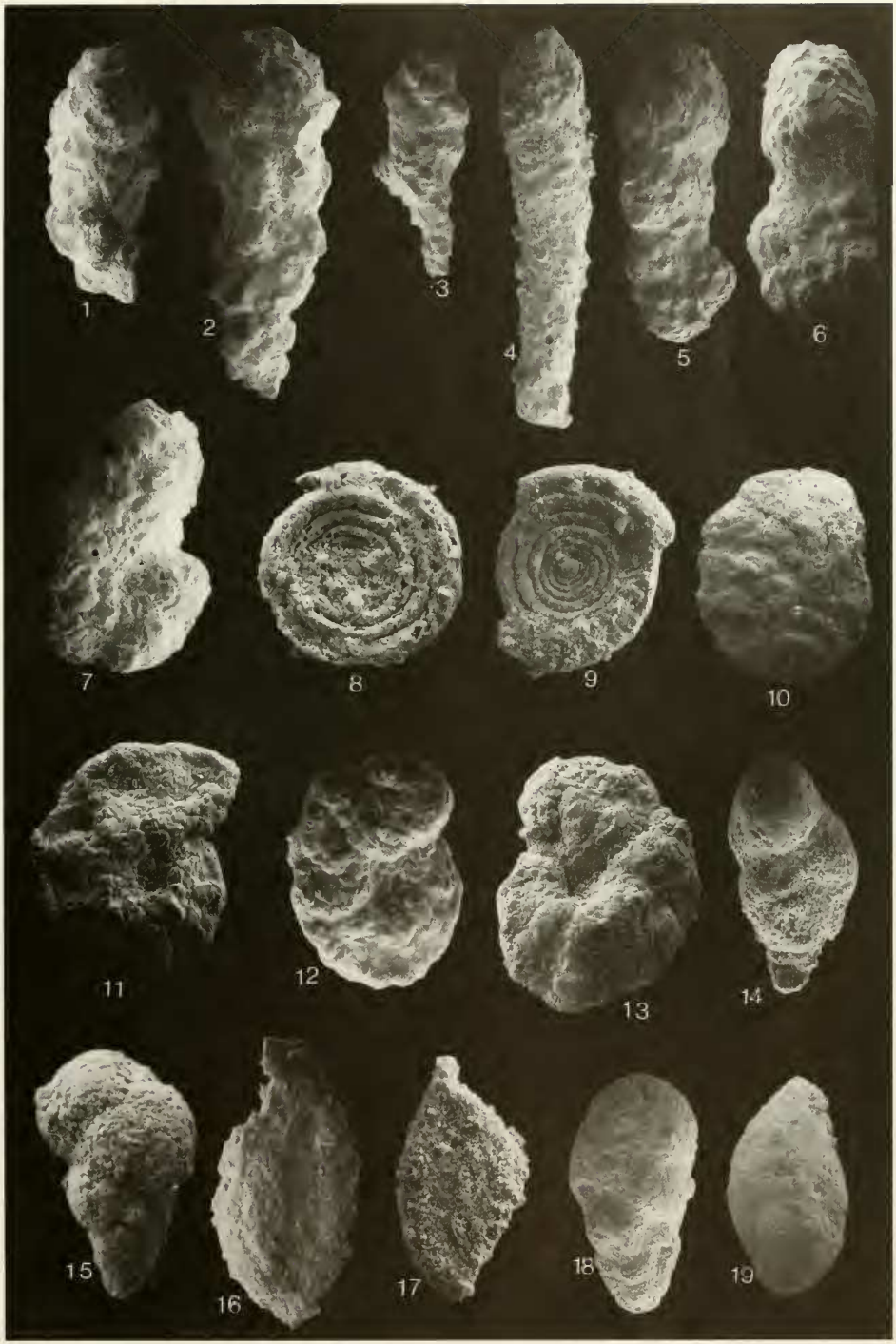
Remarks: Arda specimens yielded from samples AR-4 and AR-5 are very close related to those reported by Barnard et al. (1981) from Callovian to Oxfordian rocks of England.

Eoguttulina cf. *polygona* (Terquem, 1864)
Pl. 2, Figs. 1-2

1958 *Eoguttulina* cf. *polygona* (Terquem, 1864). - Said & Barakat: 263, pl. 1, fig. 35; pl. 2, fig. 37; pl. 5, fig. 39.

Plate 1

Fig. 1-2 *Reophax suevicus* Franke, 1936. - AR-19; Fig. 1: L = 630; Fig. 2: L = 670.
Fig. 3-4 *Reophax barnardi* Said & Barakat, 1958. - AR-19; Fig. 3: L = 1100; Fig. 4: L = 2525.
Fig. 5-7 *Ammobaculites agglutinaus* (d'Orbigny, 1846). - AR-19; Fig. 5: L = 1100; Fig. 6: L = 1030; Fig. 7: L = 860.
Fig. 8-9 *Ammodiscus zaspelovae* Kosyreva, 1972. - AR-5; Fig. 8: D = 210; Fig. 9: D = 195.
Fig. 10 *Haplophragmoides* cf. *goodenoughensis* Chamney, 1969. - AR-6; D = 310.
Fig. 11-13 *Haplophragmoides* cf. *tryssa* Loeblich & Tappan, 1950. - Fig. 11: AR-18, D = 630; Fig. 12, 13: AR-17; 12 LD = 510; Fig. 13: D = 440.
Fig. 14-15 *Verneuilinoides minuta* Said & Barakat, 1958. - Fig. 14: AR-17, L = 290; Fig. 15: AR-18, L = 270.
Fig. 16-17 *Ophthalmidium purtonensis* Barnard, Cordey & Shipp, 1981. - Fig. 16: AR-18, L = 215; Fig. 17: AR-17, L = 270.
Fig. 18 *Paramigros shinnawii* Abd-Elshafy & Ibrahim, 1990. - AR-17, L = 350.
Fig. 19 *Eoguttulina liassica* (Strickland, 1846). - AR-5; L = 290.
(L = Length, D = max. Diameter, both in microns)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Remarks: *E. polygona* occurs over a wide stratigraphic range. It is recorded from Bajocian to Kimmeridgian strata of Sinai (Said & Barakat 1958) and from Upper Callovian rocks of England (Barnard et al. 1981). Arda specimens which can be attributed to this species with uncertainty only are common in samples AR-4 and AR-5.

Astacolus ectypus Loeblich & Tappan, 1950
Pl. 2, Fig. 3

1976 *Astacolus ectypus* Loeblich & Tappan. - Souaya: 277, pl. 7, fig. 11.

Remarks: This species is a wide-ranging one. It is reported from the Sinemurian to the Middle Callovian of Canada by Souaya (1976). Arda specimens from sample AR-19 correspond in many aspects to those treated by Souaya: number of chambers approximately 13, keeled periphery, raised curved sutures which become thicker toward the umbilicus and in the initial growth stage, as well as a small radiate aperture at the extreme end of the test.

Lenticulina magharaensis Said & Barakat, 1958
Pl. 2, Fig. 4

1958 *Lenticulina magharaensis* n. sp. - Said & Barakat: 248, pl. 4, figs. 37a-b.

Remarks: This species was first reported from Kimmeridgian outcrops of Sinai. In the Arda section this species is common in samples AR-4 and AR-5.

Lenticulina quenstedti (Gümbel, 1862)
Pl. 2, Fig. 5

1958 *Lenticulina quenstedti* (Gumbel, 1862). - Said & Barakat: 248, pl. 3, fig. 24; pl. 5, fig. 34.

Remarks: Many well-preserved specimens were yielded from samples AR-19 to AR-4 of the Arda section. *L. quenstedti* is a wide-ranging fossil. It was reported from the Callovian to the Kimmeridgian from Sinai (Said & Barakat, 1958). According to Shipp (1989), it occurs in the northern hemisphere, from the Bathonian to the Kimmeridgian.

Lenticulina cf. *sossipatrovae* Gerke & Ivanova, 1972
Pl. 2, Fig. 6

cf. 1990 *Lenticulina sossipatrovae* Gerke & Ivanova in Saks, 1972. - Nagy et al.: 997, pl. 6, figs. 12-16.

Remarks: The Arda specimens were found in AR-19; they differ from typical representatives of this species in having distinctive raised sutures and a broader last chamber.

According to Nagy et al. (with cited literature herein) *L. sossipatrovae* occurs in the Lowest Neocomian of Norway and the Volgian to Valanginian of Siberia.

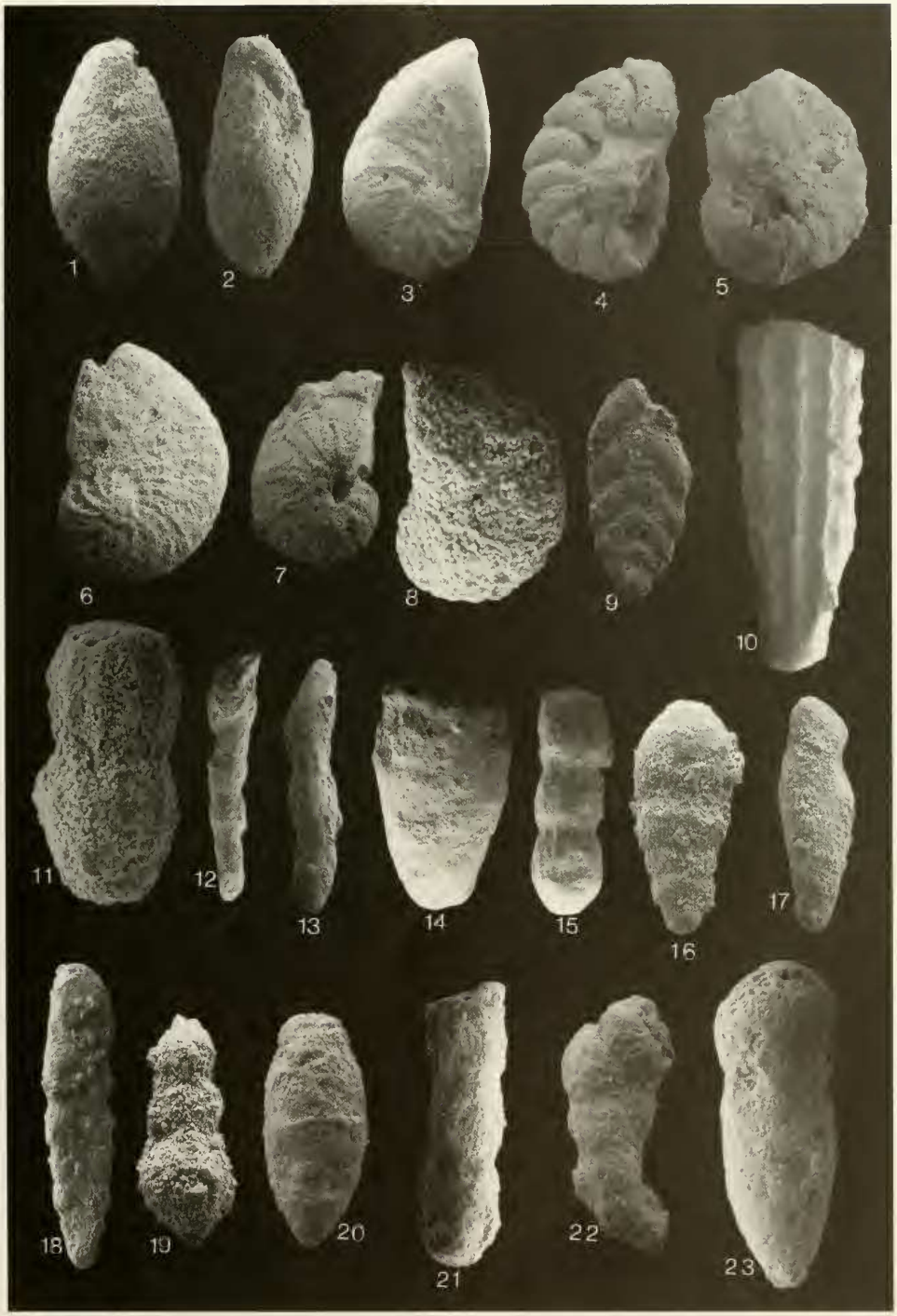
Lenticulina cf. *subalata* (Reuss, 1854)
Pl. 2, Fig. 7

cf. 1958 *Lenticulina subalata* (Reuss, 1854) - Said & Barakat: 250, pl. 1, fig. 11; pl. 2, fig. 18; pl. 3, fig. 22; pl. 4, fig. 26.

Remarks: Arda specimens from samples AR-4 and AR-5 can rather be compared with the material described by Barnard et al. (1981) than with the specimens of Said & Barakat (1958). The Arda specimens have raised curved sutures and a plane to slightly concave umbilicus; a peripheral keel is lacking. *L. subalata* is a wide-ranging fossil; it is recorded from Bajocian to Kimmeridgian strata of Sinai (Said & Barakat 1958) and from Oxfordian rocks of England (Barnard et al. 1981).

Plate 2

Fig. 1-2 *Eoguttulina* cf. *polygona* (Terquem, 1864). - AR-4; Fig. 1: L = 275; Fig. 2: L = 325.
Fig. 3 *Astacolus ectypus* Loeblich & Tappan, 1950. - AR-19; D = 1320.
Fig. 4 *Lenticulina magharasensis* Said & Barakat, 1958. - AR-4; D = 700.
Fig. 5 *Lenticulina quenstedti* (Gümbel, 1862). - AR-6; D = 700.
Fig. 6 *Lenticulina* cf. *sossipatrovae* Gerke & Ivanova, 1972. - AR-19; D = 1400.
Fig. 7 *Lenticulina* cf. *subalata* (Reuss, 1854). - AR-4; D = 500.
Fig. 8 *Lenticulina* cf. *varians* (Bornemann, 1854). - AR-5; D = 200.
Fig. 9 *Frondicularia* cf. *lignaria* Terquem, 1866. - AR-18; L = 300.
Fig. 10 *Vaginulina „prima"* Lloyd, 1958. - AR-5; L = 3270.
Fig. 11 *Nodosaria* cf. *nitidana* Brand, 1937. - AR-5; L = 200.
Fig. 12 *Dentalina intorta* Terquem, 1870. - AR-15; 630.
Fig. 13 *Dentalina* cf. *pseudocommunis* Franke, 1936. - AR-17; L = 425.
Fig. 14 *Paalzowella* cf. *feifeli* aff. *elevata* (Paalzow, 1932). - AR-5; L = 800.
Fig. 15 *Nodosaria metensis* (Terquem, 1858). - AR-5; L = 260.
Fig. 16 *Pseudobolivina* sp. 1. - AR-18; L = 330.
Fig. 17 cf. *Lingulina* sp. - AR-4; L = 300.
Fig. 18 *Pseudobolivina* sp. 2. - AR-17; L = 420.
Fig. 19 *Pseudogaudryina* sp. - AR-17; L = 370.
Fig. 20 *Palaeopolymorphina* sp. - AR-4; L = 310.
Fig. 21 cf. *Lingulonodosaria* sp. - AR-18; L = 440.
Fig. 22 cf. *Pseudogaudrynella* sp. - AR-5; L = 330.
Fig. 23 *Ellipsoglandulina* sp. - AR-4; L = 390.
(L = Length, D = max. Diameter, both in microns)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Lenticulina cf. *varians* (Bornemann, 1854)
Pl. 2, Fig. 8

cf. 1981 *Lenticulina varians* (Bornemann, 1854). - Barnard et al.: 417, pl. 2, fig. 25; text-fig. 19.

Remarks: In the Arda section this taxon rarely occurs in AR-5. Due to the somewhat poor preservation, the specimens can be attributed to *L. varians* with uncertainity only. *L. varians* is a wide-ranging fossil; its stratigraphic record extends from the Rhaetian up to the Upper Jurassic (Copestake & Johnson 1989). Said & Barakat (1958) identified it in the Bajocian and the Kimmeridgian of Sinai and Barnard et al. (1981) reported it from the Upper Callovian of England.

Frondicularia cf. *lignaria* Terquem, 1866
Pl. 2, Fig. 9

cf. 1989 *Frondicularia lignaria* Terquem, 1866. - Morris & Coleman: 224, pl. 6.3.8, fig. 5.

Remarks: Arda specimens from samples AR-17 and AR-18 differ from those of Morris & Coleman (1989) in having less ribbed sutures and fewer chambers in the last whorl (ca. 5). According to Morris & Coleman, *F. lignaria* occurs from the Aalenian to the Bathonian.

Nodosaria metensis (Terquem, 1863)
Pl. 2, Fig. 15

1958 *Nodosaria metensis* (Terquem, 1863). - Said & Barakat: 255, pl. 1, fig. 30; pl. 5, fig. 20.

Remarks: *N. metensis* is common in most of the samples of the Arda section. It is recorded from Bajocian and Kimmeridgian rocks of Egypt (Said & Barakat 1958) and from the Aalenian of England (Morris 1982 in Jenkins & Murray 1989).

Nodosaria cf. *nitidana* Brand, 1937
Pl. 2, Fig. 11

cf. 1958 *Nodosaria nitidana* Brand. - Said & Barakat: 255, pl. 5, fig. 2.

Remarks: The material from the Arda section (sample AR 5) is incompletely preserved. Only the last two chambers of the foraminifer can be found. It resembles *N. nitidana* in having inflated chambers, a radiate terminal aperture and depressed sutures. However, the identification at the species level is tentatively only. *N. nitidana* is reported from the Kimmeridgian of Sinai by Said & Barakat (1958).

Dentalina intorta (Terquem, 1870)
Pl. 2, Fig. 12

1989 *Dentalina intorta* (Terquem, 1870). - Morris & Coleman: 222, pl. 6.3.7, fig. 7.

Remarks: This species is represented by numerous specimens in samples AR-5, AR-15, AR-17 and AR-18. It is recorded from the Bajocian and Bathonian (Morris & Coleman 1989). In morphology the specimens from Jordan are very close to forms which are reported from Germany (Lutze 1960: pl. 28, fig. 17).

Dentalina cf. *pseudocommunis* Franke, 1936
Pl. 2, Fig. 13

cf. 1981 *Dentalina pseudocommunis* Franke, 1936. - Barnard et al.: 406, pl. 2, fig. 2.

Remarks: The Arda specimens extracted from sample AR-17 are very similar to the material figured and described from Middle Callovian to Lower Oxfordian strata of England by Barnard et al. (1981). The only difference is that the Arda specimens have 3 to 4 chambers in average, whereas those from England have 8.

Paalzowella cf. *feifeli* aff. *elevata* (Paalzow, 1932)
Pl. 2, Fig. 14

cf. 1960 *Paalzowella feifeli* aff. *elevata* (Paalzow). - Lutze: 485, pl. 33, fig. 11.

Remarks: Arda specimens from sample AR-5 differ from those recorded from the Lower Oxfordian rocks of Germany by Lutze (1960) in being more cylindrical rather than conical.

Vaginulina ‚prima' Lloyd, 1958
Pl. 2, Fig. 10

1989 *Vaginulina ‚prima'* Lloyd, 1958. - Shipp: 260, pl. 6.4.3., fig. 8.

Remarks: Specimens from sample AR-5 correspond closely to the specimens figured and described by Shipp (1989) in having 6-12 strong continous longitudinal ribs and a large uniserial thick-walled test. Many forms of this species were reported by Lloyd (1958, unpubl. Ph. D. Thesis, cited in Shipp 1989) from Late Kimmeridgian rocks of Great Britain.

Pseudobolivina sp. 1
Pl. 2, Fig. 16

Remarks: Four specimens of samples AR-17 and AR-18 can be attributed to this genus.

Pseudobolivina sp. 2
Pl. 2, Fig. 18

Remarks: Specimens of this taxon occur rarely in samples AR-17 and AR-18.

Pseudogaudryina sp.
Pl. 2, Fig. 20

Remarks: This species is represented by one specimen only (AR-17). It is characterized by having a highly inflated semitriangular initial part, and only two mostly round chambers in the uniserial growth stage.

Palaeopolymorphina sp.
Pl. 2, Fig. 20

Remarks: The rare specimens of this taxon from sample AR-4 are similar to those described by Barnard et al. (1981) from the Lower Oxfordian of England.

cf. *Lingulonodosaria* sp.
Pl. 2, Fig. 21

Remarks: The taxon occurs rarely in AR-17 and AR-18. It is ovate in cross-section, uniserial, rectilinear and has an elongate proloculus which is bigger than the following chambers.

cf. *Lingulina* sp.
Pl. 2, Fig. 17

Remarks: Some specimens from samples AR-17 and AR-18 can be attributed with uncertainty to the genus *Lingulina*.

?Ellipsoglandulina sp.
Pl. 2, Fig. 23

Remarks: Concerning the morphology and the very minute initial growth stage two specimens (AR-4, AR-17) are very similar to *Ellipsogladulina*. However, they differ from this genus in having compressed chambers rather than inflated ones.

cf. *Pseudogaudryinella* sp.
Pl. 2, Fig. 22

Remarks: Only one specimen from sample AR-5 was found. It is characterized by having a semitriangular initial part, followed directly by 5-6 alternating biserially arranged inflated chambers.

REFERENCES

Abd-Elshafy, E. & Ibrahim, N. (1990): New Jurassic Foraminifera from Egypt. - Acta Palaeont. Polonica, **35** (1-2): 15-29, 3 figs., pls. 1-4; Warszawa. [1]

Abed, A. (1987): New occurrence of the Jurassic in Baqa depression. - Dirasat, **14** (1): 265-274, 9 figs.; Amman.

Amereh, B. (1987): Sedimentological and Petrological Interplays of the Nubian Series in Jordan with Regard to Paleogeography and Diagenesis. - Braunschw. geol.-paläont. Diss., **7**: 232 pp., 33 figs., 6 tabs.; Braunschweig.

Aqrabawi, M. (1987): Biostratigraphy of the Jurassic rocks in Jordan „Macrofauna". - M. Sc. Thesis Jordan Univ.: 137 pp., 10 pls.; Amman.

Avnimelech, M. (1945): New Jurassic outcrop in the Jordan Valley. - Geol. Mag., **82**: 81-83; London.

Barnard, T., Cordey, W. G. & Shipp, D. J. (1981): Foraminifera from the Oxford Clay (Callovian - Oxfordian) of England. - Rev. Esp. Micropaleont., **13** (3): 383-462, 4 figs., 4 pls.; Madrid. [6]

Basha, S. (1980): Ostracoda from the Jurassic System of Jordan. - Rev. Esp. Micropaleont., **12** (2): 231-254; 3 figs., 4 pls., 4 tabs.; Madrid.

Bender, F. (1968): Geologie von Jordanien. - 230 pp., 168 figs., 1 geol. map, 21 pls.; Berlin (Borntträger).

Bielecka, W. & Geroch, S. (1977): Quelques Foraminifères du Jurassique supérieur des Carpathes externes Polonaises. - Acta 6th Coll. Afric. Micropaleont., Tunis 1977. - Annal. Min. Geol. Tunis, **28**: 185-199, 2 figs., 2 pls., 2 tabs.; Tunis.

Blake, G. S. (1936): The stratigraphy of Palestine and its building stones. - Printing and Stationary Office Report, 133 pp.; Jerusalem.

Blake, G. S. & Ionides, M. G. (1939): Report on the water resources of Transjordan and their development. Incorporating report in geology, soils and minerals, and hydrogeol. correlations; London (Crown Agents for the Colonies).

Boom, G. van den, & Lahloub, M. (1962): The Iron-Ore Deposit „Warda" in the southern Ajlun District. - Unpubl. Rep. Fed. Inst. Geosci. and Natur. Resources; Hannover.

Cooper, G. A. (1989): Jurassic Brachiopods of Saudia Arabia. - Smith. Contr. Paleobiol., **65**: 213 pp., 48 figs., 37 pls.; Washington.

Cox, L. R. (1925): Bajocian-Bathonian outcrop in the Jordan Valley and its Molluscan remains. - Ann. Mag. Nat. Hist., **9** (15): 169-181; London.

Copestake, P. & Johnson B. (1989): The Hettangian to Toarcian (Lower Jurassic). - In: Jenkins, D. G. & Murray, J. W. (eds.): Stratigraphical atlas of fossil foraminifera, 2nd edit.: 129-188, 10 figs., 6 pls.; Chichester (Ellis Horwood).

Ellis, B. F., Messina, A. R., Charmatz, R. & Ronai, L. E. (1969): Catalogue of Index smaller Foraminifera, Vol. 3, Mesozoic - Tertiary benthonic Foraminifera. - Spec. Publ. Amer. Mus. Nat. Hist.; New York.

Geroch, S. & Koszarski, L. (1988): Agglutinated foraminiferal stratigraphy of the Silesian Flysch Trough. - 2nd Workshop on agglutinated Foraminifera, Vienna 1986, Abh. Geol. B.-A., **41**: 73-79, 3 figs.; Wien.

Goldberg, M. & Friedman, G. M. (1974): Paleoenvironments and paleogeographic evolution of the Jurassic system in southern Israel. - Geol. Surv. Israel, Bull., **61**: 1-44, 16 figs., 8 pls.; Jerusalem.

Hegab, A. A. & Tkhorzhevsky, E. S. (1992): Terebratulida (Brachiopoda) from the Upper Jurassic of Anti-Lebanon, Syria. - Bull. Fac. Sci., Assiut Univ. Egypt, **21** (1F): 1-30, 7 figs., 1 pl.; Assiut.

Hirsch, F. & Picard, L. (1988): The Jurassic facies in the Levant. - J. Petrol. Geol., **11** (3): 277-308, 15 figs.; Beaconsfield.

Hoeker, J. (1957): Foraminiferen der Oberkreide von Nordwest-Deutschland und Holland. - Beih. Geol. Jb., **27**: 464 pp., 495 figs.; Hannover.

Jenkins, D. G. & Murray, J. W. (eds.) (1989): Stratigraphical Atlas of Fossil Foraminifera. - 2nd edit.: 592 pp., New York, Chichester (Ellis Horwood).

Kuss, J. (1990): Middle Jurassic calcareous algae from the Circum-Arabian area. - Facies, **22**: 59-86, 5 figs., 1 tab., 21 pls.; Erlangen.

Libbey, W. & Hoskins, F. (1905): Jordan Valley and Petra. - Bull. Amer. Geol. Soc., **38**: 96-97; New York.

Loeblich, A. & Tappan, H. (1988): Foraminiferal genera and their classification. - 970 pp.; 847 pls.; New York (van Nostrand Reinhold).

Lutze, G. F. (1960): Zur Stratigraphie und Paläontologie des Callovian und Oxfordian in Nordwest-Deutschland. - Geol. Jb., **77**: 391-532, 20 figs., 21 pls.; Hannover. [26]

Morris, P. H. & Coleman, B. E. (1989): The Aalenian to Callovian (Middle Jurassic). - In: Jenkins, D. G. & Murray, J. W. (eds.), Stratigraphical atlas of fossil foraminifera, 2nd edit.: 189-236, 6 figs, 12 pls.; Chichester (Ellis Horwood).

Muir-Wood, H. M. (1925): Jurassic Brachiopods from the Jordan Valley. – Ann. Mag. Nat. Hist., 9 (15): 181-192; London.

Nagy, J., Lofaldli, M. & Backström, S. A. (1988): Aspects of Foraminiferal distribution and depositional conditions in Middle Jurassic to Early Cretaceous shales in Eastern Spitzbergen. - 2nd Workshop on agglutinated Foraminifera, Vienna 1986, Abh. Geol. B.-A., **41**: 287-300; 8 figs.; Wien.

Nagy, J., Pilskog, B. & Wilhelmsen, R. M. (1990): Facies controlled distribution of Foraminifera in the Jurassic North Sea Basin. - In: Hemleben, C., Kaminski, M. A., Kuhnt, W. & Scott, D. B. (eds.), Paleoecology, Biostratigraphy, Paleoceanography and Taxonomy of Agglutinated Foraminifera, NATO ASI Series, Ser. C, **237**: 621-657, 22 figs.; Dordrecht (Kluwer).

Nagy, J., Lofaldli, M., Backstrom, S. A. & Johansen, H. (1990): Agglutinated foraminiferal stratigraphy of Middle Jurassic to basal Cretaceous shales, Central Spitzbergen. - In: Hemleben, C., Kaminski, M. A., Kuhnt, W. & Scott, D. B. (eds.), Paleoecology, Biostratigraphy, Paleoceanography and Taxonomy of Agglutinated Foraminifera, NATO ASI Series, Ser. C, **237**: 969-1015, 12 figs., 6 pls.; Dordrecht (Kluwer).

Okla, S. M. (1986): Litho- and microfacies of Upper Jurassic carbonate rocks outcropping in Central Saudi Arabia. - J. Petrol. Geol, **9** (2): 195-206, 7 figs, 3 pls.; Beaconsfield.

Risch, H. (1969): Stratigraphie der höheren Unterkreide der bayerischen Kalkalpen, mit Hilfe von Mikrofossilien. - Diss. Ludwig-Maximilians-Univ. München, 180 pp., 18 pls.; München.

Rogl, K. D. (1988): Early Cretaceous agglutinated Foraminifera from limestone-marl rhythmites of the Gresten Klippen Belt, Eastern Alps (Austria). - 2nd Workshop on agglutinated Foraminifera, Vienna 1986, Abh. Geol. B.-A., **41**: 41-59, 10 figs., 3 pls.; Wien.

Said, R. & Barakat, M. G. (1958): Jurassic microfossils from Gebel Maghara, Sinai, Egypt. - Micropaleontology, **4** (3): 231-272, 5 figs., 1 tab., 6 pls.; New York. [35]

Shahin, A. & El-Beialy, S. (1989): Microfossils from the Middle Jurassic Shusha Formation of the Gabal al Maghara, Sinai, Egypt. - N. Jb. Geol. Paläont. Mh., **1989** (9): 560-575, 6 figs.; Stuttgart.

Shipp, D. J. (1989): The Oxfordian to Portlandian. - In: Jenkins, D. G. & Murray, J. W. (eds.), Stratigraphical atlas of fossil foraminifera. - 2nd edit.: 237-272, 6 figs., 3 pls.; Chichester (Ellis Horwood). [37]

Souaya, F. J. (1976): Foraminifera of Sun-Gulf Global Linckens Island Well P-46, Arctic Archipelago, Canada. - Micropaleontology, **22** (3): 249-306, 6 figs., 12 pls.; New York. [38]

Wetzel, R. & Morton, D. M. (1959): Contributions à la géologie de la Transthe jordan. - Notes et Memoires sur le Moyen-Orient, 7: 95-188; Paris.

Numbers in brackets behind some references refer to numbers given in table 2.